

Critical Requirements of a Modeling System

The basic skeletal models (e.g., tetrahedrons, octahedrons, icosahedrons, etc.) that can be created by each of the designs (Trantow and cited prior art) all look somewhat the same at first glance. However this does not mean the capabilities of the designs are the same. Designs either succeed or fail when put to the test of whether they allow the model builder to easily build complex forms so that the builder can truly explore the organizing principles of three-dimensional geometric form. I roughly define a complex form, to be a skeletal model with over one hundred nodes and struts at minimum, with several hundred possible. By contrast, the basic shapes shown in patent applications will have in the range of 10 nodes and struts (i.e., basic and complex differ by orders of magnitude).

There are two vital aspects to consider, usability (ease of use) and scalability (ability to grow large and maintain structural integrity). A system must possess both, for indeed, if usability and scalability are not key criteria for distinguishing a novel and successful design then every geometric modeling system that has been patented thus far would have been rejected by the prior art established by historical geometric systems where users simply glued toothpicks together to form 3D stick models. While it is possible to build models in this way, it is of course, very arduous and difficult to do and would defeat the patience of most people to build anything but very basic forms.

The ability to scale in complexity without increasing the difficulty of assembly as the model grows is achieved by the physical design and operation of the node and strut elements, and the Trantow design excels all other prior art in this regard.

Distinguishable Design Differences and Why They are Important

The uniqueness of the Trantow design is in the relationship and inter-working of the node pin with the thin, flat and flexible end-tabs-with-hole that can be stacked and sandwiched onto the node pin. There are several useful and non-obvious benefits of this design over the cited prior art that are described below.

Brumlik and Ochrymowich

The Trantow design allows easy assembly and disassembly of models that have structural integrity even at a very large scale. Simply put, in a Trantow system, building a complex model is no more difficult than building a basic model, i.e., the effort remains constant. This is not the case with Brumlik and Ochrymowich.

In the Trantow design the flexible end-tabs are strongly attached to each end of the strut element, such that, the flexible end-tab and the interior shaft effectively become a single unit, i.e., a rigid shaft section with thin flexible ends. Attachment of the flexing end-tab to the rigid strut section occurs prior to building geometric models. This strut design is a critical requirement for creating large complex models which Brumlik and Ochrymowich cannot easily accomplish. When constructing models with the Trantow design multiple end-tabs will be stacked upon the node pin through holes in the end-tab such that the orientation of the lay of the end-tabs on the node pin is always roughly perpendicular to the axis of the node pin. Thus any pull force (tension) exerted parallel to the line of the strut must always pull against the node pin itself which is able to resist (sink) that force. In practice, as you add more and more struts and nodes, the increase in model volume and weight, the increase in number of interconnections from multiple directions all contribute to exert a pull force that is parallel to the line of the struts. (It is like if you attached a belt around a balloon and started to blow it up. Eventually the expansion of the balloon will exert a pulling force on the buckle.) This inherent pull force puts strain on the attachment point of the strut piece to the node piece and acts to pull it apart. Unless the node-to-strut attachment is strong enough this inherent force will cause an unwanted detachment of the node from the strut section at some stage in the model build-out and this effectively stops model growth (i.e., the construction is dead in the water). The Trantow design anticipates this inherent strain and prevents unwanted node separation because the flexible end-tabs are sufficiently strongly affixed to the strut piece prior to model building. Brumlik and Ochrymowich, however, do not anticipate this force and their design is problematic because node elements are affixed to the strut during model construction. This is a key distinguishing point. In order for the model builder to be able to easily construct the model, the node pieces of Brumlik and Ochrymowich must be reasonably easy to insert into the hollow tubular shafts, else it will defeat the patience of the model builder. In their designs you have to slide the 'flexible fingers' of the node piece into the tubes, and this must be done without too much friction resistance else it would be too difficult to accomplish. However, it will be impossible in a practical sense to design the node pieces such that they can both be conveniently inserted into the tubular strut piece and yet also have the gripping friction to withstand the pulling forces inherent to a large complex model. Unless you have some type of locking mechanism, which Brumlik and Ochrymowich do not describe, their node attachment system simply cannot satisfy these two opposing requirements, i.e., easy-in, hard-out. Thus, unless the user were to take extraordinary effort to apply glue or other extra means to permanently bond the node piece to the tubular section, at some point in the build-out, the inherent pull force exerted at the nodes of the model will overcome the friction that holds the node piece into the tube and separate them. Thus these designs cannot scale up to large and complex. By contrast the Trantow design can withstand the tension associated with any size of model and thus can scale to very large complex models.

Having to glue together (or any other special fixing technique) together Brumlik or Ochrymowich struts to the node pieces to overcome the node separation problem not only diminishes its usability, it also diminishes its value as an educational tool because a truly useful tool must also allow for easy disassembly so it can be re-used. The Trantow design allows for consistent easy assembly and also consistent easy disassembly – simply pull

the node pins out of the end-tab stack, i.e., a single operation. This provides two advantages: it allows you to easily undo a mistake during model build-out, and of course, allow you to de-construct a model quickly so you can start a new construction (re-use).

In summary, there is an inherent and critical flaw to the Brumlik and Ochrymowich designs which prevent them from scaling in complexity unless the model builder takes extraordinary and undesirable effort to prevent unwanted node separation such as gluing. The system thus fails as an effective educational tool for form exploration, because it is simply too hard to create complex forms (i.e., it is not much better than the historical method of gluing toothpicks together). And, should indeed the user spend the extra time and effort to work-around the node separation problem, because nodes and tubes would then have to be permanently affixed to hold together, re-use of the struts and nodes is now impossible. This means the user of this system will effectively be able to build, with difficulty, one large complex model and that's it. By contrast the Trantow design succeeds as an educational tool by providing an easy, intuitive means of creating of large, unanticipated, and complex geometric models that can just as easily be disassembled to allow for re-use in an ongoing practice of geometric form study. The unique design and operation of the Trantow node and strut elements enables this capability, and I argue that this makes it patently distinguishable from Brumlik and Ochrymowich.

Gabriel/Chen

The Gabriel/Chen design is fundamentally different than both the Trantow and the Brumlik and Ochrymowich designs in that the strut-to-node intersections are rigid versus flexing. The Gabriel/Chen design itself is a tacit acknowledgement of the node separation problem. Here struts attach to hollow sphere-like node pieces with a snap-lock mechanism. The struts have a barbed end that is inserted into pre-defined holes in the node pieces. When they are inserted far enough the barbs catch and prevent the strut from pulling apart under the aforementioned strains inherent to large, complex models. To disassemble, the user must squeeze each strut at its end to compress it so that the barbs release and it can be pulled out of the node piece.

As pointed out in the December 13th Amendment, in essence, Gabriel/Chen does not teach the same design or operating principles as the Trantow design. An important difference is their dependence upon the use of pre-defined interface points (holes) in the node piece. This has several disadvantages:

- 1) It forces the user to have to think (analyze) in advance about which hole to use every time a strut is connected to a node piece. This diminishes ease of use. In practice this can be difficult to do as forms grow in size and complexity, and this requirement likely will prevent (i.e., defeat their patience) most people from achieving complex models. Such pre-thought is not required in the Trantow design because struts, once they are attached onto the node pin, can be freely rotated around the node pin and flexed upward or downward to achieve any spatial angle. Thus the user simply connects struts together by maneuvering struts around so as to intersect them at their end-tabs and then pin them together. This is a simple intuitive process that is a fundamental and distinguishing difference from the Gabriel/Chen design.

- 2) The hole placements in the Gabriel/Chen node piece ultimately dictate which kinds of model are possible, i.e., only those geometric forms that intersect at the angles that system manufacturer has defined for the node pieces. The Trantow design by contrast does not have any such limitations, another distinguishing design difference.
- 3) In the Gabriel/Chen design during model assembly it is necessary to widen the distance between nodes in order to insert the struts into the node. When the barbs are clipped in place, the nodes un-widen and return to the correct distance. This is easy at first but as the as number interconnections between adjacent nodes grows it starts to solidify the spatial distance between adjacent nodes and at some point it gets hard to move the node in any direction because it is being held in place by the adjacent nodes. In the Gabriel/Chen design ease of use diminishes as size and complexity of the model increases. In the Trantow design this does not occur because struts are attached by placing them onto the node pins which are generally in perpendicular orientation to the growth line of the model, hence, unlike Gabriel/Chen you do not have to widen the existing nodes in order to attach a new strut. The flexible (compensating) characteristic of the end-tab allows for a consistent operational usability.
- 4) In disassembly, the Gabriel/Chen design requires the user to physically squeeze the end of each strut to un-clip it from the node piece. In a large complex model there will be hundreds of such connections therefore disassembly will be difficult and time consuming thus diminishing the overall usability of the tool. By contrast, in the Trantow design, to disassemble a model the user need only pull out the node pin to release all the struts at that node. This means a complex model with many interconnections at each node there is roughly an order of magnitude fewer operations required to disassemble a Trantow model than Gabriel/Chen.

In summary, the Gabriel/Chen design is inferior to the Trantow design in terms of usability and scalability. It can scale to large size but it is limited in its potential for complexity and diversity. Model construction is hampered by having to pre-think on which holes to attach to, likely causing more mistakes in build-out that have to be undone. Because struts must be attached along the axis of the strut itself, when there are a lot of interconnections it can be difficult to pull the model apart to allow for strut insertion. Finally, strut detachment is more difficult, i.e., squeeze and pull out every strut one at a time, making model disassembly arduous.

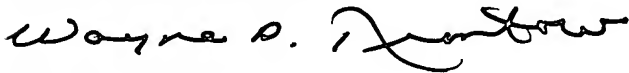
Concluding Argument

Designs either succeed or fail when put to the test of whether they allow the model builder to easily build large complex forms so that the builder can truly explore the organizing principles intrinsic to three-dimensional form. The Trantow design allows easy and intuitive build-out that scales to sizes and complexities that are limited only by the number of struts available to the builder, not by any operational limitations. By contrast Brumlik and Ochrymowich cannot be both easy to assemble and scale-up in size

and complexity due to the aforementioned node separation problem. Gabriel/Chen does not provide the builder with true freedom of form exploration. The builder is limited to spatial patterns that are pre-defined by the hole pattern in the node elements (which is a fundamentally different design principle to Trantow). So while it can scale to large sizes (because it handles node separation problem) model complexity is limited when compared to Trantow. Furthermore, the process to build large models requires of the user thoughtful decisions about which holes to attach to during build-out (i.e., non-intuitive). Therefore, Gabriel/Chen in a practical sense fails to make it easy to assemble large complex models.

I submit that design of the Trantow strut and node and their inter-working is non-obvious and is a patentably distinguishable better design of a 3D geometric modeling system. It is the only design that makes it possible for anyone to create unanticipated complex forms and learn from that experience, without defeating their patience. I respectfully request that you allow all the aforementioned claims and grant a patent for this system.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Wayne P. Trantow". The signature is fluid and cursive, with the last name being more prominent.

Wayne Trantow
Inventor

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